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Morphological analysis of the adult and juvenile instars of *Scutovertex minutus* (Acari, Oribatida, Scutoverticidae)

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Morphological analysis of the adult and juvenile instars of *Scutovertex minutus* (Acari, Oribatida, Scutoverticidae). - Individuals of *Scutovertex minutus* (Koch, 1836) were investigated originating from different regions of eastern Austria, Italy (Southern Tyrol), and Switzerland. Because of the fragmentary descriptions and scattered morphological data of this species it is necessary to redescribe it in detail. Characteristics for adult *S. minutus* are: Granular cerotegument; rounded rostrum; prodorsal median ridges, which converge early and do not reach the translamella; notogastral setae $h_{2\text{-}3}$ and ps_1 distally slightly lanceolate, h_1 mostly a little broadened distally, blunt, and spinose; mentum with irregularly interrupted sclerotized transverse rib; leg chaetome (without solenidia): I (1-4-3-4-18), II (1-4-3-4-15), III (2-2-1-3-15), IV (1-2-2-3-12). Intraspecific morphological variation was observed in the shape of lamellar cusps and translamella, and in the length of prodorsal median ridges, in the shape of lenticulus and in the number of notogastral setae (10-12 pairs). Breeding experiments produced all juvenile instars which are here described in detail for the first time. Larva and nymphs in general show conformity in their habitus. Basic characteristics in juveniles are the plicate surface of the hysterosoma, larva with 12 and nymphs with 15 pairs of short gastronotic setae, reddish lateral opisthosomal glands, short lamellar, interlamellar and exobothridial setae. Conspicuous characters in the larval stage are the long and thick setae h_2 and in the nymphs the knife-shaped lateral setae *l'* and *l"* on tibia I.

Keywords: Taxonomy - morphology - postembryonic development - intraspecific variation.

INTRODUCTION

Scutovertex minutus (Koch, 1836) is the earliest described and apparently the most common representative of the genus *Scutovertex* Michael, 1879. The reported findings show a Palaearctic distribution. Although this species is known since 171 years, no detailed description or redescription is available. In spite of that, this species is often mentioned in papers dealing with the ecology and distribution of oribatid mites living in extreme environments as rocks, roofs, salt marshes or inundation meadows (e.g., Franz & Beier, 1948; Willmann, 1951; Weigmann, 1973).

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Moreover, our knowledge of the juvenile stages is very poor. Only Grandjean (1946, 1949) and Haarløv (1957) gave some information on morphological characters and Smrž (1992) described some histological features of the juveniles of *S. minutus*.

The goal of this paper is to redescribe the adults of *S. minutus* and to describe the juvenile stages of this species in detail. These results should provide basic data of external morphology for further comparative investigations on other species of Scutoverticidae.

MATERIAL AND METHODS

Collecting: Adults and juveniles of *Scutovertex minutus* can be found throughout the year. They were extracted with Berlese-Tullgren funnels from mosses and lichens collected on sun exposed rocks and roofs in the eastern parts of Austria.

Collecting sites (numbers in parentheses refer to the numbers of specimens examined):

Lower Austria: Asparn / Zaya: Eastern outskirt of the village; mosses and lichens on a tiled roof; 230 m; 16.11.1996; leg. E. Ebermann – (8). Traunstein: "Wachtstein-Camp"; mosses from rocks on the border of the parking site; 930 m; 31.05.2004 – (1). Türkensturz, Pittental: Mosses in rock crevices; 310 m; 17.10.1997; leg. R. Schuster – (2).

Upper Austria: Urfahrer Wänd: W Linz; mosses and lichens of a rock; 300 m; 02.05.1997; leg. R. Schuster – (1).

Styria: Frauental, near the castle; mosses and lichens of a tiled roof; 340 m; May 1996; leg. E. Ebermann – (10). Gleichenberger Kogel: Quarry; lichens from rocks; 570 m; 15.06.1991; leg. R. Schuster – (2); 11.02.2007 – (2). Stiwoll: Mosses of the graveyard wall; S- and SW-exposed; 500 m; 23.08.2004 – (2). Öblarn: Mosses from a wall on the riverbank of the river Enns; S-exposed; 670 m; 05.04.2006 – (2). Pogier near Kapfenberg: Mosses from roof of an old hut: 680 m; 02.10.2006 – (6).

Carinthia: Laas: NW Hermagor; near the parking site of the hospital; mosses from rocks; SW-SE-exposed; 830 m; 02.09.2004; leg. P. Horak – (1).

Italy, Southern Tyrol: Lüsen, 23.08.1998; ex Coll. Schatz – (7)

44 individuals from these samples were analyzed morphologically and about 50 adults were taken for breeding experiments to get larvae and nymphs.

Microscopic slides from museum collections : Museum of Natural History, Basel; Coll. Schweizer: Switzerland, Neuenstadt; slide no. 1477 (labelled as *Scutovertex sculptus*) – (8 specimens in one slide).

Bavarian State Collection of Zoology Munich (ZSM); Coll. Willmann: Switzerland, Grindelwald, 03.10.1913, slide no. A20041022 – (1 specimen).

Reference material: 10 adult specimens, collected in Styria, stored in ethanol, deposited in the Muséum d'histoire naturelle, Genève.

Breeding: Adults were put in cylindrical polystyrol-boxes (diameter about 1.5 cm) with a bottom of moistened plaster of Paris. Mosses and lichens taken from the bark of trees served as food source. To avoid the growth of fungi in the boxes, hyphae were removed with a fine, soft paintbrush every day.

FIGS 1-4

S. minutus, adult. (1) Habitus, dorsal aspect; arrowheads indicate the position of notogastral saccules S_1, S_2, S_3. (2) Lateral part of prodorsum and rostrum; arrowheads point to the two projecting rostral ridges; arrow indicates the 'V-shaped' tutorium. (3) Pedipalp in lateral view. (4) Habitus, ventral aspect (legs omitted).

PREPARATION: The collected specimens were preserved in 70% ethanol. A differential interference contrast microscope (Olympus BH-2, equipped with a drawing tube) was used for investigation in transmitted light. Some specimens were embedded in lactic acid (as clearing agent) using concavity slides, others were mounted in Swan-medium (a mixture of arabic gum, aqua dest., glucose, chloral hydrate and glacial ethanoic acid) as permanent slides. Micrographs were taken with a digital camera (Olympus Camedia C4040 zoom). For scanning electron microscopy the specimens were dehydrated in ascending ethanol concentrations, dried in air, mounted on aluminium-stubs with double sided adhesive tape and coated with gold. SEM-micrographs were taken at the Research Institute for Electron Microscopy, Technical University Graz with a Zeiss Leo Gemini DSM 982.

ABBREVIATIONS used in figures: *a* = anterior subcapitular seta; *ad* = adanal seta; *ag* = aggenital seta; *an* = anal seta; bo = bothridium; bS = sensillus; Ch = chelicere; c_{1-3}, *da, la, dm, lm, dp, lp,* h_{1-3}, ps_{1-3} = notogastral setae; *ex* = exobothridal seta; ε = famulus on tarsus I; *ft"*= fastigial seta; *g* = genital seta; G = gena; *gla* = opening of lateral opisthosomal gland; *h* = hysterostomatic seta; *in* = interlamellar seta; *im, iad* = lyrifissures; *le* = lamellar seta; Le = lenticulus; lg = labiogenal articulation; M = mentum; *m* = median subcapitular seta; Pdp = pedipalp; ro = rostral seta; RU = rutellum; $\omega_{1,2}$ = solenidia on tarsus; *1a, 1b, 1c, 2a, 3a, 3b, 4a, 4b* = epimeral setae.

RESULTS

ADULTS

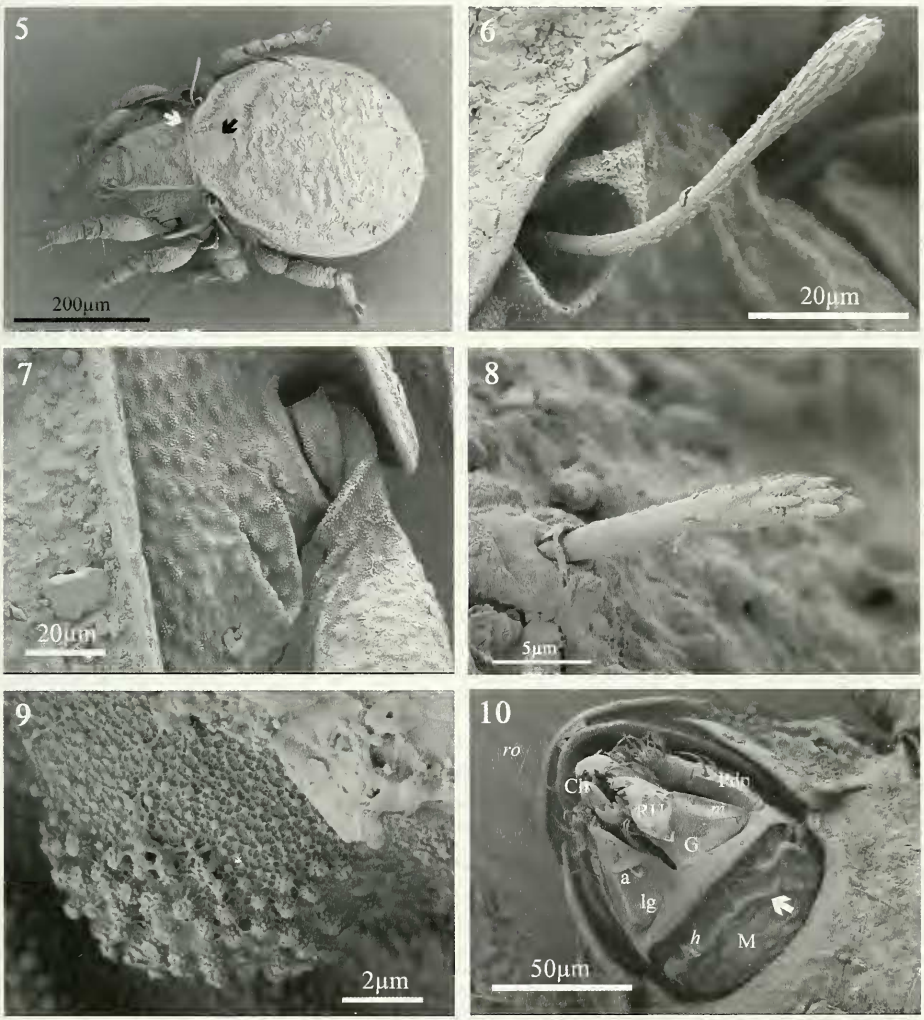
DIAGNOSIS: Habitus corresponding to a typical *Scutovertex*. Cerotegument (on notogaster) granulate, cuticle dark and heavily sclerotized, without foveae. Median converging ridges of prodorsum not reaching translamella. Rostrum anterior of translamella with circular ridge. Sensillus clavate, spinose. Mentum with irregularily interrupted sclerotized transverse rib. 10-12 pairs of notogastral setae; setae h_{2-3} and ps_1 distally slightly lanceolate, h_1 often a little broadened distally, blunt, and spinose. Leg chaetome (excluding solenidia): I (1-4-3-4-18), II (1-4-3-4-15), III (2-2-1-3-15), IV (1-2-2-3-12).

DESCRIPTION: *Habitus* (Figs 1, 5): Body contour oval in dorsal view; colour dark brown to black (in living individuals), in lactic acid and ethanol more light-coloured.

Measurements (n=40): Mean total length: 589 µm (range 550-659 µm). Mean notogastral width: 347 µm (range 325-380 µm).

Integument (Fig. 5): Cerotegument granulate, covering entire body and leg segments; some granules fused to irregular bars. Whole cerotegument giving the specimens a rough surface. Granules in cavities and protected areas of the body smaller and interconnected, forming a reticulate pattern (Fig. 9). Cuticle without foveae.

Prodorsum (Figs 1, 2): Rostrum in dorsal view characterised by a circular ridge, its anterior part visible in lateral view (Fig. 2) as a projecting ridge. Additionally, on the outermost part of the rostrum a second ridge projecting beyond the anterior part of the circular one and looking like a narrow rostral lobe. Rostral setae inserting near lateral end of this distal ridge. Distinct lamellae; lamellar cusps mostly short and broad, sometimes long. Lamellar setae originating at the top of cusps and curving towards



FIGS 5-10

S. minutus, adult. (5) Habitus, dorsal aspect; black arrow points to the lenticulus; white arrow indicates the cuticle bar on the border between prodorsum and notogaster. (6) Sensillus and bothridium in dorsal view. (7) Dorsal view of left lateral part of prodorsum with V-shaped tutorium and base of leg I. (8) Notogastral seta h_3, slightly lanceolate and spinose distally. (9) Nodule in the humeral region containing lyrifissure *ia* covered with reticulated cerotegument. (10) Camerostome and subcapitulum in ventral view; arrow indicates transverse rib of mentum.

each other. Translamella broad and straight or narrow and slightly bent caudad connecting lamellae. Between bothridia two convergent ridges fused in the middle of prodorsum and running rostrad, not reaching translamella. Interlamellar setae absent.

Sensillus (Fig. 6) flat, clavate and spinose. Bothridium wide and cup-like, margin without incision; antiaxial side showing a small apophysis with a ridge running ventrally.

A V-shaped cuticular elevation (Figs 2, 7) rostrad of leg I placed as the tutorium.

Notogaster (Figs 1, 5): Oval; suture between notogaster and prodorsum incomplete medially. Lateral borders of lenticulus concave or parallel or slightly convex. No pteromorpha, only humeral projections. Octotaxic system represented by three pairs of very small saccules (S_1-S_3). 10-12 pairs of setae: c_2, *da*, *dm*, *dp*, *la*, *lp*, h_{1-3} and ps_{1-3}; *da* and/or *dp* reduced in most cases (12 pairs observed only once); sometimes setae reduced one sided. Setae h_{2-3} and ps_1 distally slightly lanceolate and spinose (Fig. 8), h_1 often a little broadened distally, blunt, and spinose. Other setae acute; setae *lp* the longest, rest of setae decreasing in length rostrad and caudad. A small, projecting cuticular nodule under the humeral projection (Fig. 9) with a weak slit (lyrifissure *ia*) visible in transmitted light. Lyrifissure *im* latero-median on the notogaster, *ip* dorsally of the line seta ps_1 and ps_2; *ih* and *ips* on the posterior lateral border of the notogaster. Openings of lateral opisthosomal glands located in line of lyrifissures *im* and setae h_3; reservoir of the gland narrow but elongated.

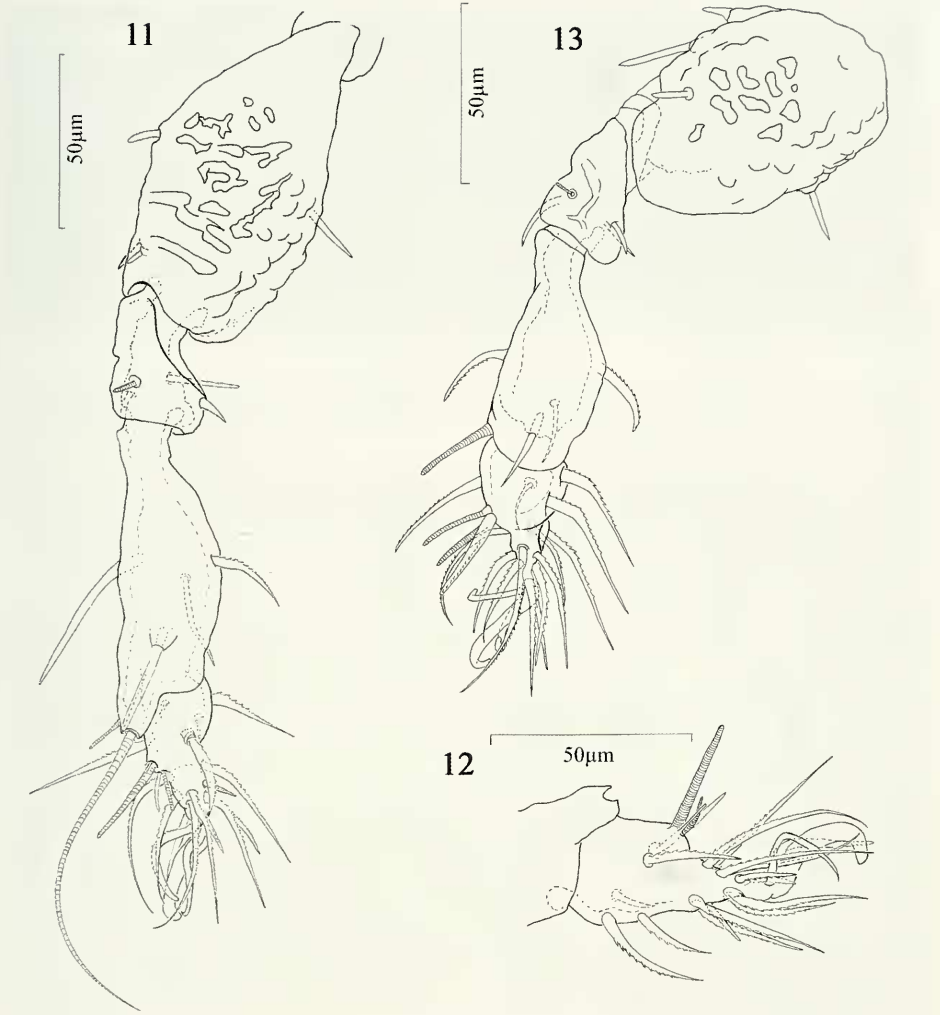
Rostrum and *camerostome* (Fig. 4): Rostrophragma forming inner margin of camerostome (Fig. 10). A longish triangular lamella originating from the posterolateral corner of the camerostome running parallel to the inner border of the camerostome rostrad; distal end of lamella overlapped by rostral lobe. No genal incision.

Gnathosoma: Subcapitulum diarthric (Fig. 10); rutellum pantelebasic, distally with four teeth, first one the strongest. Genae possessing sharp lateral edges, one pair of anterior subcapitular setae (*a*) and median subcapitular setae (*m*), both finely serrate. An irregularly interrupted sclerotised rib running across the mentum; the simple hysterostomatic setae (*h*) inserting on it. Pedipalp with five articles (Fig. 3); chaetome: 0-2-1-3-9. Solenidia: 0-0-1. Setae on each segment (femur to tarsus) spiniform and of different lengths. The four tarsal eupathidia bacilliform, with slightly broadened basis. Solenidion recumbend, distal end touching the basis of eupathidium *acm*. Porous axillary sacculus at basis of pedipalp. Chelicerae with two setae: *cha* longer than *chb*. Trägardh's organ of same length as moveable digit of chela.

Epimeral region (Fig. 4): Setal formula: 3-1-2-2. All setae acute, slim and smooth, seta *1c* located at basis of pedotectum I. Pedotectum I large, completely hiding acetabulum I. Pedotectum II strongly developed, in horizontal plane "Y-shaped". Apodemata different, either reaching median axis or shorter, depending on the degree of sclerotization of the individuals. Apodemata IV always absent.

Anogenital region (Fig. 4): Genital valves approximately trapezoid. Genital setae: Six pairs; the two foremost pairs inserting next to each other, the median pair about twice as long as the lateral pair. One pair of aggenital setae, latero-caudally of genital opening. A transversal furrow situated closely behind genital opening, whose ends directed towards the acetabula IV. Anal valves long, posteriorly broadened. A ridge running along axial border of the valves, between those a groove. A shallow groove antiaxially of this ridge. Preanal organ cup-like. Two pairs of anal setae inserting antiaxially of the ridges; setae smooth, acute and slim, an_1 longer than an_2. Lyrifissures *iad* situated laterally near front edge of anal orifice. Adanal setae ad_1 and ad_2 located posterior to anal orifice, ad_3 lateral to it; all of these setae short and spiniform, inserting on small cuticular bumps.

Legs (Figs 11-18): Tarsi with fine-grained cerotegument except on distal end. Apotele tridactyl; median claw dorsally weakly spinose, crescent-shaped and stronger



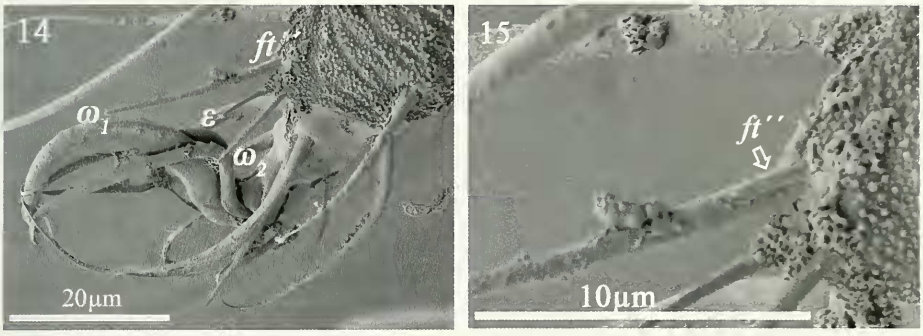
FIGS 11-13

S. minutus, adult. (11) Left leg I (tarsus to femur), antiaxial, ventrolateral aspect. (12) Right tarsus I, antiaxial aspect. (13) Left leg II, antiaxial aspect.

than the two lateral, clearly spinose claws. All femora with one dorsal stigma, from there one trachea running to distal part of tibia (legs I-III) or to proximal part of tarsus (leg IV); in legs I and II a second short trachea running in opposite direction and ending within femur. Additionally, one trachea within trochanter of legs III and IV; stigma opening proximally paraxially. Chaetome and solenidia of legs see Table 1. Leg I (Figs 11, 12): Femur elongated, with short irregular ridges. Genu shortest segment with a conspicuous ridge; solenidion (σ) on a small bump. Solenidia of the tibia inserting on a strong apophysis distally; φ_1 very long, whip-shaped, φ_2 short and straight. Tarsal solenidia (ω_1 and ω_2 – second one thinner and shorter than first one), famulus (ε) and

TABLE 1. *Scutovertex minutus*; leg setation of all instars. First development of setae characterised by letters, if in parentheses ( ) = pairs of setae; – = no change with regard to the preceding stage. σ, φ, ω = solenidia. Numbers in [ ] = individual variation.

	Instars	Trochanter	Femur	Genu	Tibia	Tarsus	Chaetome	Solenidia
Leg I	**Larva**		*d bv"*	*(l) d* σ	*(l) v" d* φ_1	*(ft) (tc) (p) (u) s (a) (pv) (pl)* ε ω_1	0-2-3-4-16	1-1-1
	Protonymph		–	–	–	–	0-2-3-4-16	1-1-2
	Deutonymph		*(l)*	–	–	ω_2	0-4-3-4[5]-16	1-2-2
	Tritonymph	*v"*	–	*v'*	*v'* φ_2	*(it)*	1-4-4-5-18	1-2-2
	Adult	–	–	*d* lost	*d* lost	–	1-4-3-4-18	1-2-2
Leg II	**Larva**		*d bv"*	*(l) d* σ	*l" v" d* φ	*(ft) (tc) (p) (u) s (a) (pv)* ω_1	0-2-3-3-13	1-1-1
	Protonymph		–	–	–	–	0-2-3-3-13	1-1-1
	Deutonymph		–	–	*l'*	ω_2	0-4-3-4-13	1-1-2
	Tritonymph	*v"*	*(l)*	*v'*	*v'*	*(it)*	1-4-4-5-15	1-1-2
	Adult	–	–	*d* lost	*d* lost	–	1-4-3-4-15	1-1-2
Leg III	**Larva**		*d ev'*	*l' d s*	*v d j*	*(ft) (tc) (p) (u) s (a) (pv)*	0-2-2-2-13	1-1-0
	Protonymph		–	–	–	–	0-2-2-2-13	1-1-0
	Deutonymph	*v'*	–	–	–	–	1-2-2-2[3]-13	1-1-0
	Tritonymph	*l'*	–	–	*(l)*	*(it)*	2-2-2-4-15	1-1-0
	Adult	–	–	*d* lost	*d* lost	–	2-2-1-3-15	1-1-0
Leg IV	**Protonymph**					*ft" (p) (u) (pv)*	0-0-0-0-7	0-0-0
	Deutonymph		*d ev'*	*d l'*	*v' d j*	*(tc) s (a)*	0-2-2-2-12	0-1-0
	Tritonymph	*v'*	–	–	*l' v"*	–	1-2-2-4-12	0-1-0
	Adult	–	–	–	*d* lost	–	1-2-2-3-12	0-1-0



FIGS 14-15

S. minutus, adult; distal part of tarsus I. (14) Solenidia and famulus. (15) Basal part of solenidion ω_1 with short companion seta *ft''*.

seta *ft''* close to each other (Figs 14, 15). Leg II (Fig. 13): Femur stocky, with thick cerotegument. Solenidion of genu (σ) short and delicate. Tibial solenidion (φ) long and situated distally. Tarsus with two slim and long solenidia. Leg III (Figs 16, 17): Trochanter with approximately triangular shape. Femur broad, with ribbed surface, ventrally with lamella. Solenidion of genu (σ) on an inconspicuous bump. Tibial solenidion (φ) short. Seta *ft''* of tarsus long, spiniform. Leg IV (Fig. 18): Trochanter big, broad. Femur elongated, ventrally with lamella; cuticle with conspicuous short irregular ridges. Tibia long, slim; solenidion (φ) short. Seta *ft''* of tarsus long, spiniform.

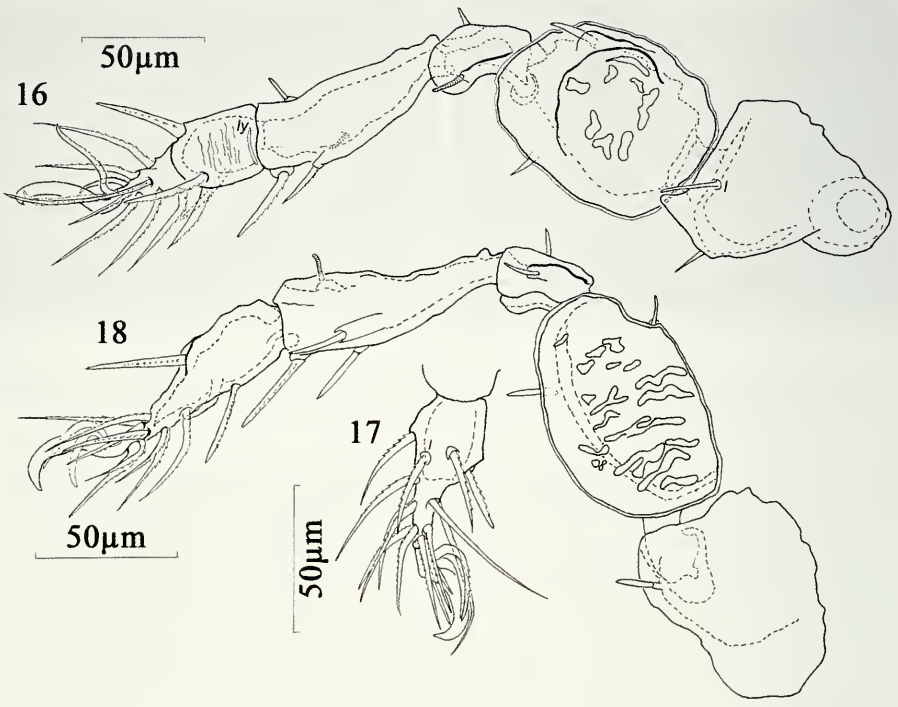
JUVENILE INSTARS

In general larva, proto-, deuto- and tritonymphs show conformity in their habitus and they just vary in measurements depending on their postembryonic stage. Therefore characters that are the same in all stages are mentioned first. Subsequently, typical features of each juvenile stage will be described.

Habitus: Oval with irregular plication in dorsal view (Fig. 19). Cuticle grey in permanent slides, only variation in different stages from light grey to dark grey. Living individuals also grey with silver glimmer. Weakly sclerotised, especially on notogaster and legs. Cerotegument shows various structures in different body regions (Figs 20, 22, 23).

Prodorsum: Rostrum different from that of adults. Rostral setae long, but lamellar setae primarily very short, acute and inserting on small bumps. The latter not in same position as in adults, situated more caudally and more medially in the first third of prodorsum. No lamellar cusps present. Sensillus relatively long, clavate and spinose. Bothridium cup-like and big. One pair of interlamellar setae (*in*) located between bothridia; very short and acute in larval stage, tip cone-shaped in nymphal stages (Fig. 21). Exobothridal setae near bothridium, often hardly visible because of wrinkled cuticle. Lenticulus not distinct as in adults; a rectangular slight elevation situated between bothridia in front of the plicate notogastral area (see Fig. 19).

Hysterosomatic region: Conspicious prodorsum and hysterosomatic region separated by an almost straight suture. Circular reservoirs of lateral opisthosomal



FIGS 16-18

S. minutus, adult. (16) Right leg III, antiaxial aspect. (17) Left tarsus III, antiaxial aspect. (18) Right leg IV, antiaxial aspect.

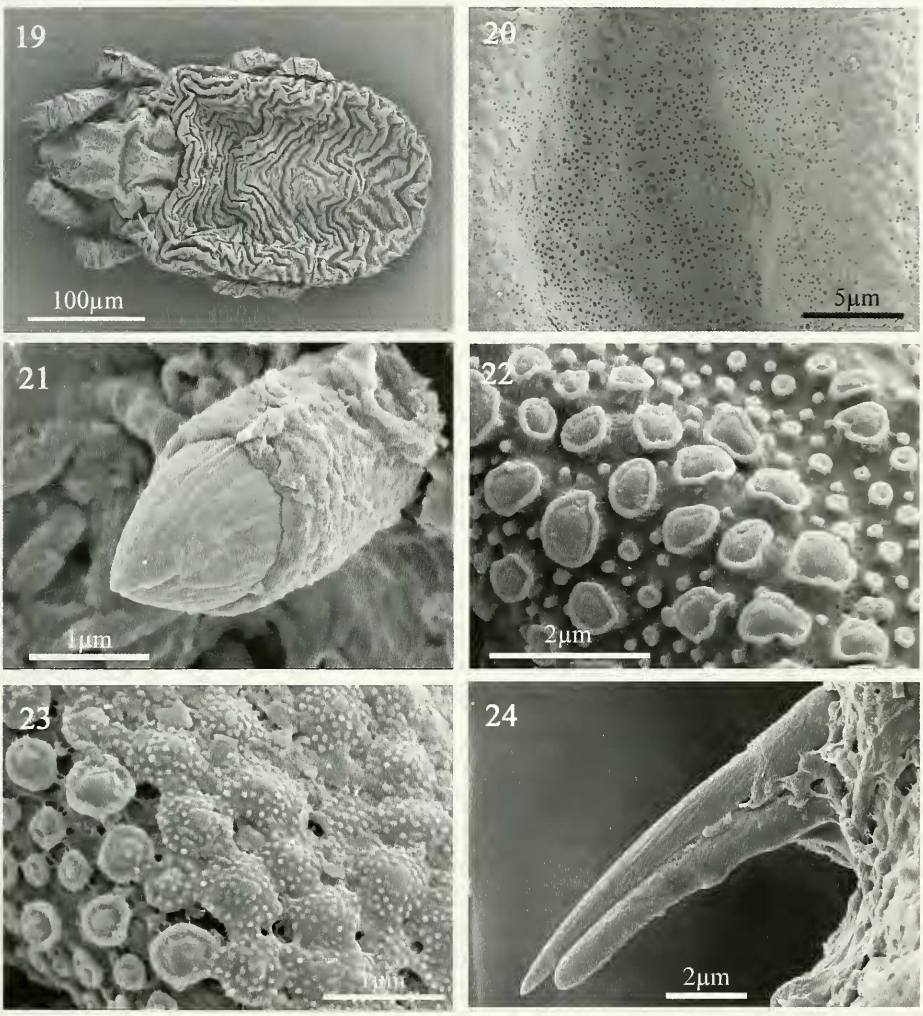
glands situated postero-laterally; their reddish content shining through the cuticle of living individuals but this stain disappearing on permanent slides. Cupules (lyrifissures) always developed as faint disk-like structures; their number corresponding to the stages (see below).

Gnathosoma: Nymphal subcapitulum with axillary saccules on basis of palps as in adults.

Epimeral region: Number of setae different between juvenile stages. Median area of epimera covered with fine wrinkles. Apodemata not reaching median axis.

Anogenital region: Whole anogenital region wrinkled like dorsal part of hysterosoma.

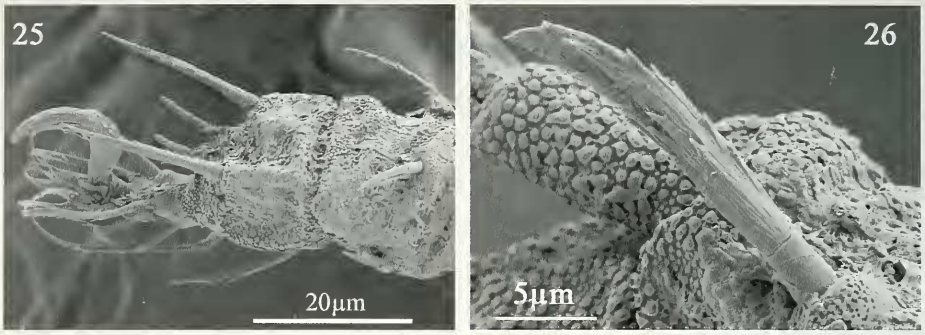
Legs: Cerotegumental structure (Fig. 22) consisting of mushroom-like structures. Most of these formations coated with another fine granulated layer (Fig. 23). No tracheae in legs, but at least femora showing porose areas in the deuto- and tritonymphal stage. Number of setae increasing from stage to stage. Chaetome and solenidia of legs, see Table 1. Dorsal setae on genu and tibia paired with the solenidium (Fig. 24). Various setae differing in length, thickness and serration (e.g., Fig. 25). Lateral setae (*l'* and *l''*) on tibia I of nymphs of special form: Thick, knife-shaped and serrate (Fig. 26).



FIGS 19-24

S. minutus. (19-21) Deutonymph. (19) Habitus, dorsal view. (20) Fine structure of cerotegument between two wrinkles of notogastral cuticle. (21) Right interlamellar seta. (22-24) Tritonymph. (22) Cerotegument of right tarsus I, axial aspect, near *ft"*. (23) Cerotegument of leg III. (24) Solenidion φ with companion seta *d* of tibia II.

LARVA (Figs 27, 31): Body length (n=3): 247-250 µm. Body width: 156-163 µm. Translamella not discernible in this stage. Rostral setae straight and forward-directed. 12 pairs of gastronotic setae: $c_{1\text{-}3}$, *da, la, dm, lm, dp, lp,* $h_{1\text{-}3}$. Cupules *ia* and *im* in dorsal aspect visible; *ih* anterior and *ip* posterior to anal orifice. Epimeral setae: 2-1-2; seta *1c* on epimeron I not developed. Anal valves hardly visible because of wrinkled cuticle. Two pairs of notogastral setae h_2 and h_3 near anal valves. Setae h_3 short and acute, inserting lateral of the valves; h_2 remarkably long and thick, located



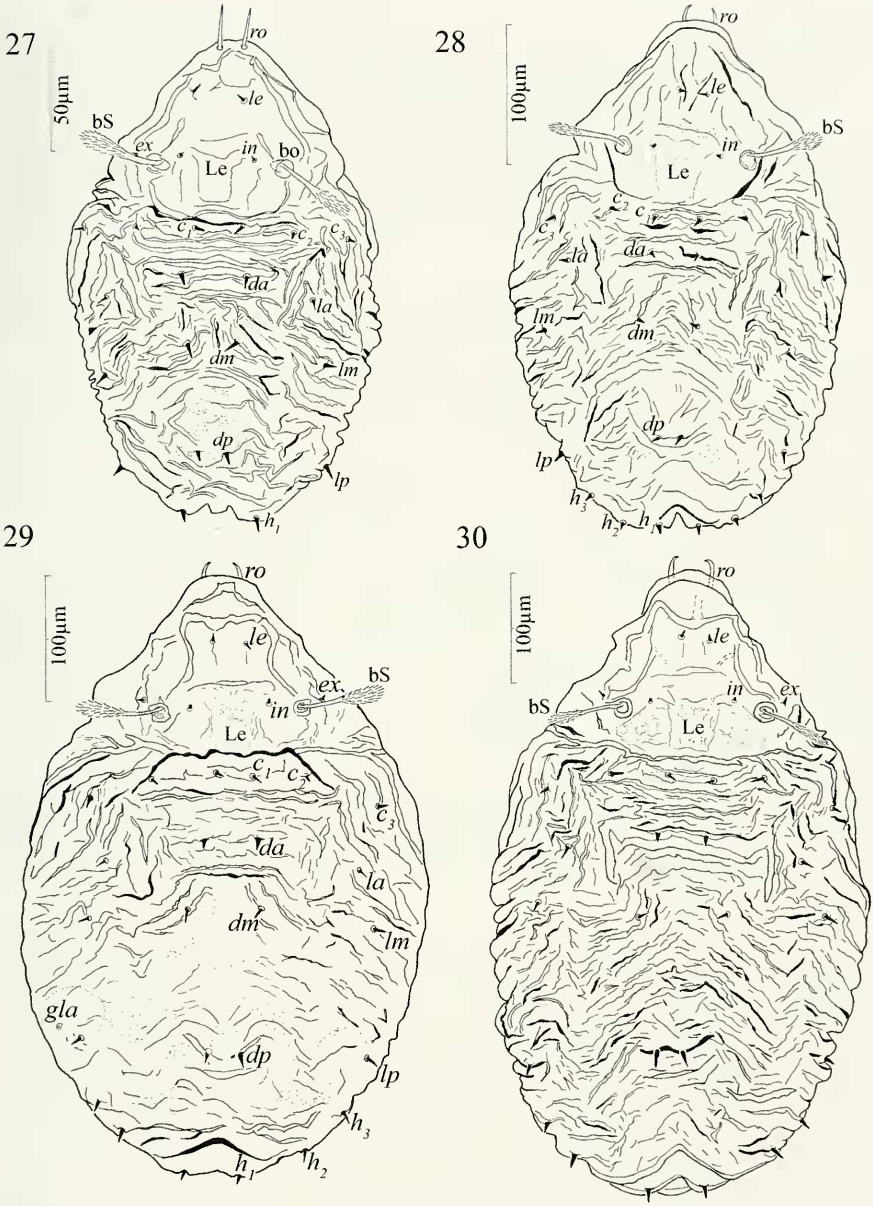
FIGS 25-26
S. minutus, tritonymph. (25) Left tarsus II, antiaxial aspect. (26) Right tibia I, lateral seta *l'*.

caudally (see Fig. 31). Legs (Figs 35-37). Apophysis on leg I approximately as long as tibia. Claparède organs dome-shaped.

PROTONYMPH (Figs 28, 32): Body length (n=2): 350-375 µm. Body width: 219-231 µm. No distinct lamellae and translamella. 15 pairs of short gastronotic setae, c_{1-3} thin, the remaining ones thicker. Cupules *ips* lateral near front edge of anal valves; *ih* and *ip* displaced laterally. Formula of epimeral setae: 3-1-2-1; seta *4a* in the middle of epimeron IV. One pair of genital setae on genital valves. Aggential, anal and adanal setae not developed. Legs (Figs 38-41).

DEUTONYMPH (Figs 29, 33): Body length (n=6): 450-500 µm. Body width: 281-325 µm. Rostral setae slightly curved towards each other. Cuticular ridges extenting rostrad from bothridium, apically transversally connected. The short and acute lamellar setae close behind this transversal ridge. 15 pairs of short and slim gastronotic setae inserting on bumps of different height; location same as in protonymphs. Cupules *iad* situated in same position as in adults; *ips* dislocated next to *ih*. Formula of epimeral setae: 3-1-2-2; seta *4b* situated near the median axis. Genital valves clearly outlined; still narrow and almond-shaped in closed condition. Two or three pairs of genital setae present. One pair of aggential setae lateral of genital valves. Anal valves already well-developed but without anal setae. Three pairs of adanal setae (first appearance in juveniles), situated laterally of anal valves. Legs (Figs 42-45). Two of the raised individuals showing intraspecific variation in their leg chaetotaxy: One specimen with five setae on right tibia I and four on left tibia I; another one with three setae on both tibiae III.

TRITONYMPH (Figs 30, 34): Body length (n=3): 531-613 µm. Body width: 338-406 µm. Prodorsal ridges resembling lamella and translamella of adults; short and acute lamellar setae behind ridges. Rostral setae long and curved towards median axis. Lateral opisthosomal gland poorly shining through the cuticle because of darker colour of individuals. 15 pairs of short and acute gastronotic setae. Cupules *ips* displaced posteriorly in line of *ih* and *ip*. Formula of epimeral setae: 3-1-2-2. Each genital valve with five setae. One pair of aggenital setae latero-caudally of valves. Anal valves



FIGS 27-30

S. minutus, juveniles; habitus in dorsal view. (27) Larva. (28) Protonymph. (29) Deutonymph. (30) Tritonymph.

narrow and elongated. Valves surrounded by two adanal plates, each of them with three adanal setae. Setae ps_1, ps_2 and ps_3 laterally and caudally of anal region inserting on short bumps. Legs (Figs 46-49): Tibia I longer than in previous stages, therefore apophysis relatively shorter.

DISCUSSION

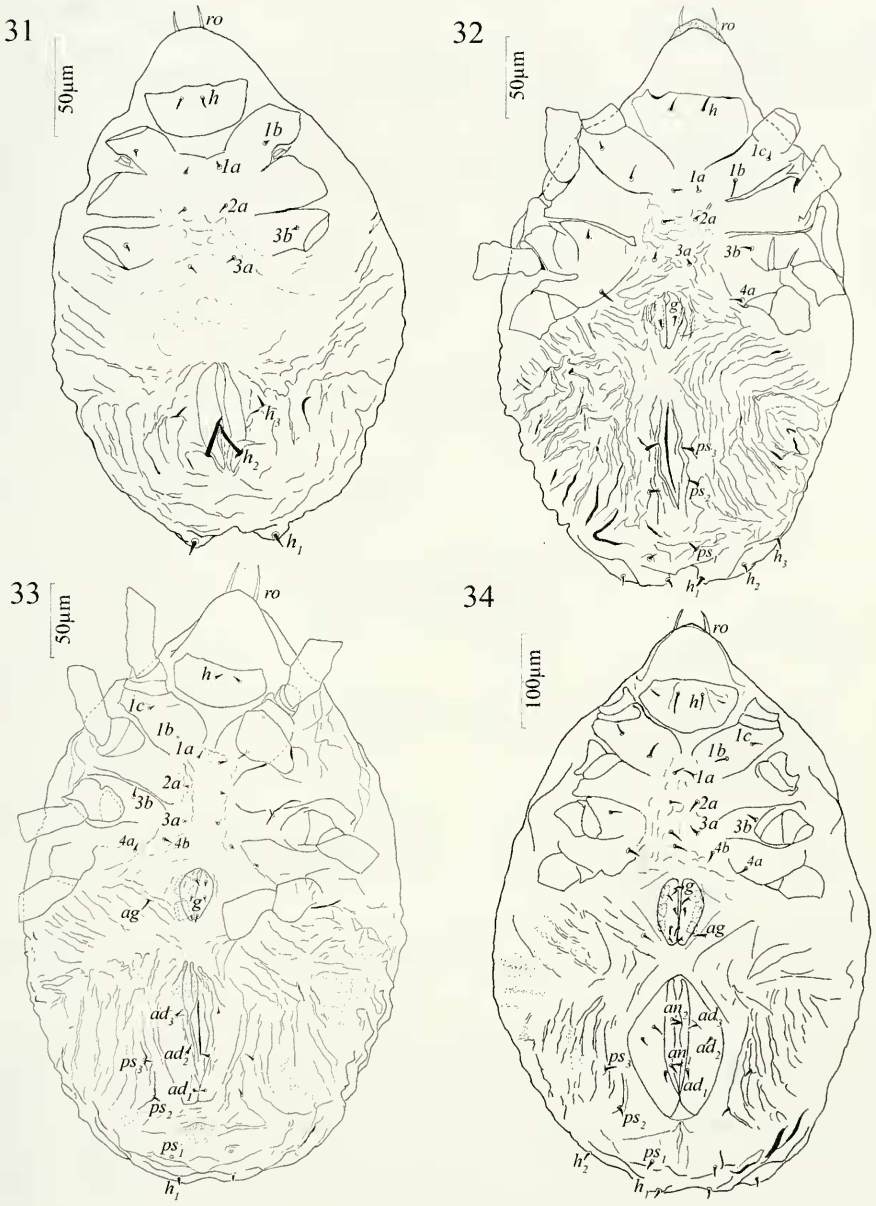
Adults

We decided to morphologically analyse the adults of *Scutovertex minutus* in detail, because of the many not yet examined features on the one hand and because of the existence of different figures of this "species" in oribatid papers and keys on the other hand. Drawings of the dorsal view of *"S. minutus"* show diverging body shapes, various sensilli, and homologous notogastral setae of different length and shape (compare Strenzke, 1943; Schweizer, 1956; Ghiljarov & Krivolutsky, 1975; Balogh, 1972, 1992; Pérez-Iñigo, 1993).

The types on which the original description by C. L. Koch is based were collected from the moat of Regensburg (Bavaria). Our two attempts to collect additional *S. minutus* material in Bavaria (Großer Arber, Neu Schwanstein) were not successful. Unfortunately, no *Scutovertex*-specimens of the collection of C. L. Koch are still available for comparison; requests addressed to the Museum of Natural History, Berlin, and to the Museum of Natural History of London brought no positive results. The short descriptions of *S. minutus* (Koch, 1836) and *S. ovalis* (Koch, 1841) and Koch's tiny illustrations of these species allowed a free and broad interpretation of their characters in the past. The description of *S. sculptus* Michael, 1879 seems not to have been helpful for most acarologists in the first half of the 20th century. In 1928 Sellnick presumed that *S. minutus* and *S. sculptus* are synonyms. Van der Hammen (1952) reported on incorrectly labelled microscopic slides of *Scutovertex*-species in the collections of Berlese and Oudemans. We also found that phenomenon in three different collections: Schweizer identified at least once *S. minutus* as *S. sculptus* (slide no. 1477). Furthermore, most *Scutovertex*-slides of the collection Willmann are labelled as *S. ovalis,* although Willmann only mentioned *S. minutus* and *S. sculptus* in his key of 1931. However, in our investigation of his slides we could not find any noticeable differences between the specimens of *S. minutus* and *S. ovalis*. Some vials of the collection Moritz are labelled as *S. minutus*, others as *S. sculptus* – none of them contain *S. minutus*.

Although Strenzke (1943) already demonstrated some clear differences between *S. minutus* and *S. sculptus*, his work was neglected by many authors, resulting in different opinions on the characteristics of this species (see above). Later, Strenzke relativised his work in a note sent to Haarløv (1957: 47) mentioning the problem of determination based on variation of characters and asking for an investigation of specimens originating from a wide area and from different habitats to clarify this problem. Haarløv himself regarded *S. minutus* and *S. sculptus* as synonymous because of "intermediate forms".

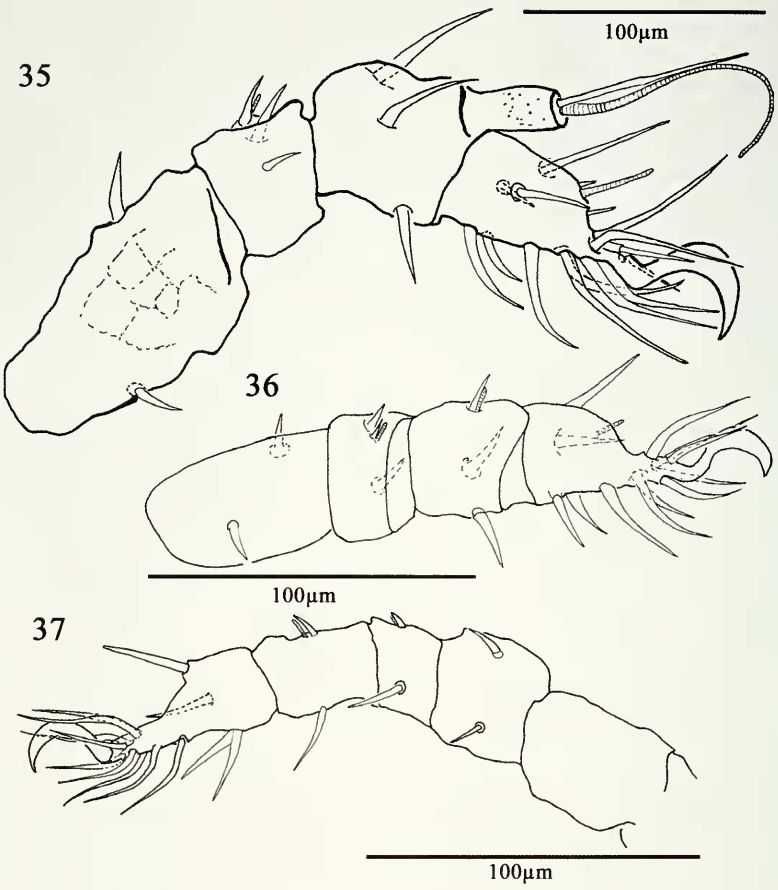
In our study, which refers to material from eastern Austria, supplemented by specimens from S-Tyrol and Switzerland, we restrict the limits of the species *S. minutus* according to our diagnosis. Intraspecific variation includes the number of notogastral setae, shape of lamellar cusps, and of prodorsal ridges. In general our results correspond to the characters and figures given in the key of Weigmann (2006). He reported on facultative problems to distinguish between *S. minutus* and other species caused by a relatively high intraspecific variation (see also Pérez-Iñigo, 1993). We do not agree with the hypothesis of such a high extent of intraspecific variation assumed



FIGS 31-34

S. minutus, juveniles; habitus in ventral view (subcapitulum not drawn). (31) Larva (note the strong setae h_2). (32) Protonymph. (33) Deutonymph. (34) Tritonymph.

by the authors mentioned above. Even though we have also found specimens not completely corresponding to our diagnosis, we want to exclude these "diverging specimens" from determination or description at the present state of knowledge. We

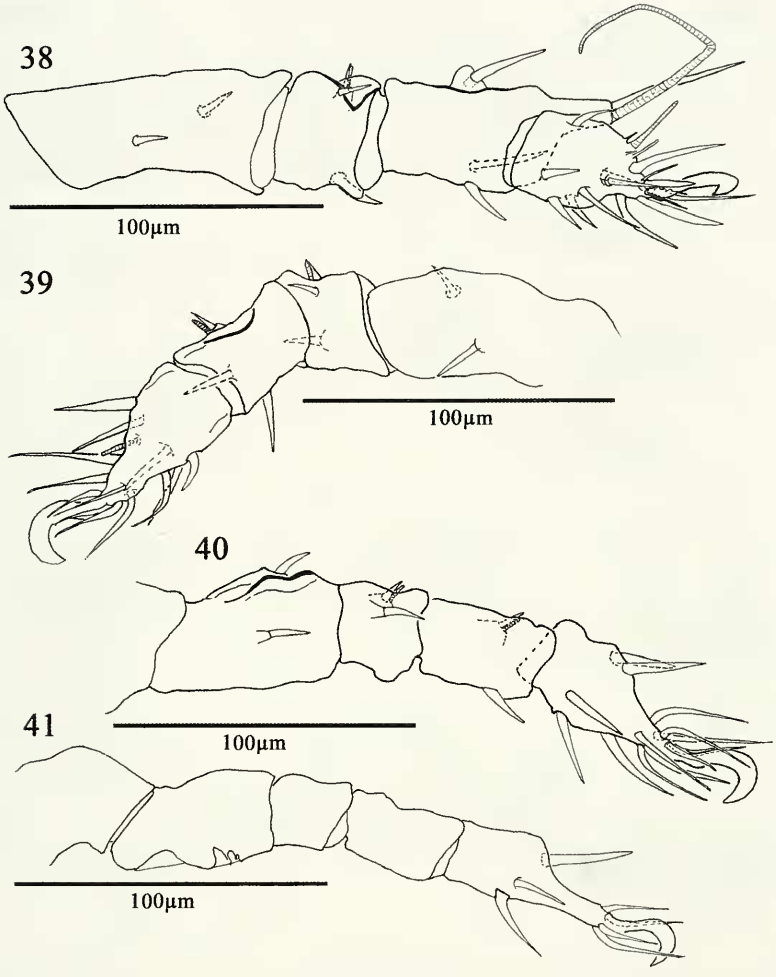


FIGS 35-37

S. minutus. Larva. (35) Right leg I, antiaxial aspect. (36) Left leg II, axial aspect. (37) Right leg III, antiaxial aspect.

assume that future results of an ongoing detailed morphological and molecular genetic study of other European species (e.g., *S. sculptus, S. alpinus*) collected from various places will clarify the taxonomic status of these "intermediate forms". Therefore, and due to the limited knowledge on morphological characters and their intraspecific variation in other species, we omit a detailed comparison between *S. minutus* and the remaining *Scutovertex*-species in order to avoid the false impression that these species are already well-defined.

Morphological characters as camerostome, lyrifissure *ia* and tracheae of legs, could play an important role in the classification of genera of Scutoverticidae: Although Grandjean (1952) already stated that *Scutovertex* does not possess a genal incision, Ghilarov & Krivolutsky (1975) as well as Sitnikova (1980) reported on an aberrant notch on the border of the camerostome. SEM investigations of the lateral

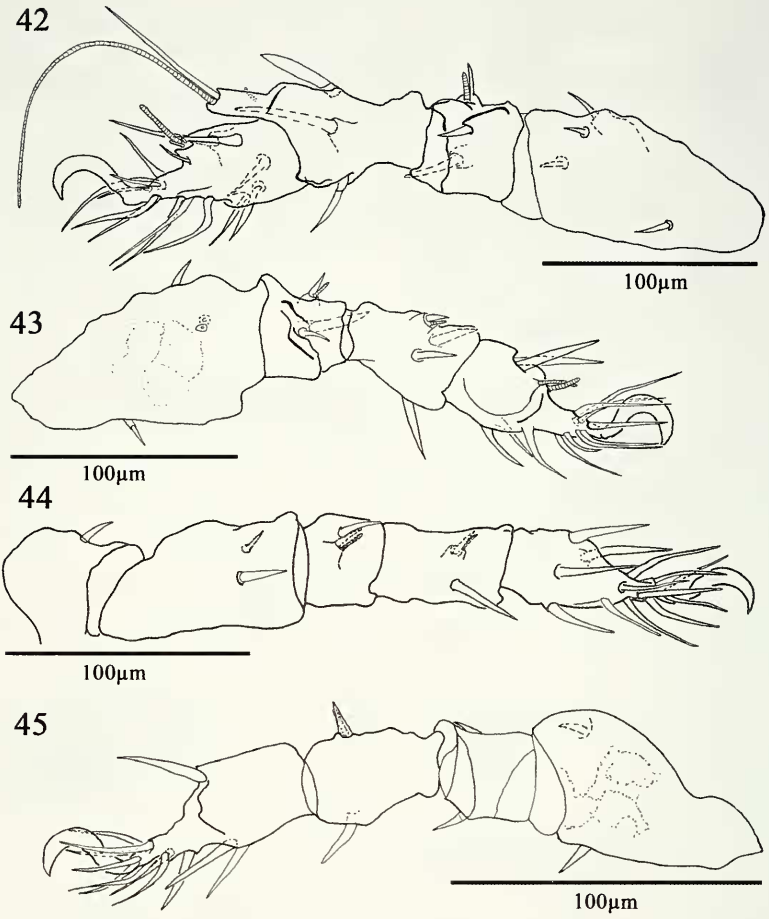


FIGS 38-41

S. minutus. Protonymph. (38) Right leg I, antiaxial aspect. (39) Left leg II, antiaxial aspect. (40) Left leg III, antiaxial aspect. (41) Left leg IV, antiaxial aspect.

parts of the podosoma have shown that there is no (genal) incision or cleft in the rostral margin. Nevertheless, these morphological details of the border of the camerostome might be important in studying the relationships of Scutoverticidae.

The cuticular nodule (see Fig. 9) under the humeral projection shows in transmitted light a small slit which represents the lyrifissure *ia*; otherwise the *ia* would be missing. This nodule probably has its equivalent in a similar disc-like structure described in *Argentinovertex coineaui* Fernandez & Cleva, 2002. In this case the authors have neither found a slit on the disc-like structure, nor the lyrifissure *ia*. The position and the form of this organ might be comparable to the humeral organ of other Poronota, but histological investigations are necessary to clarify this problem.



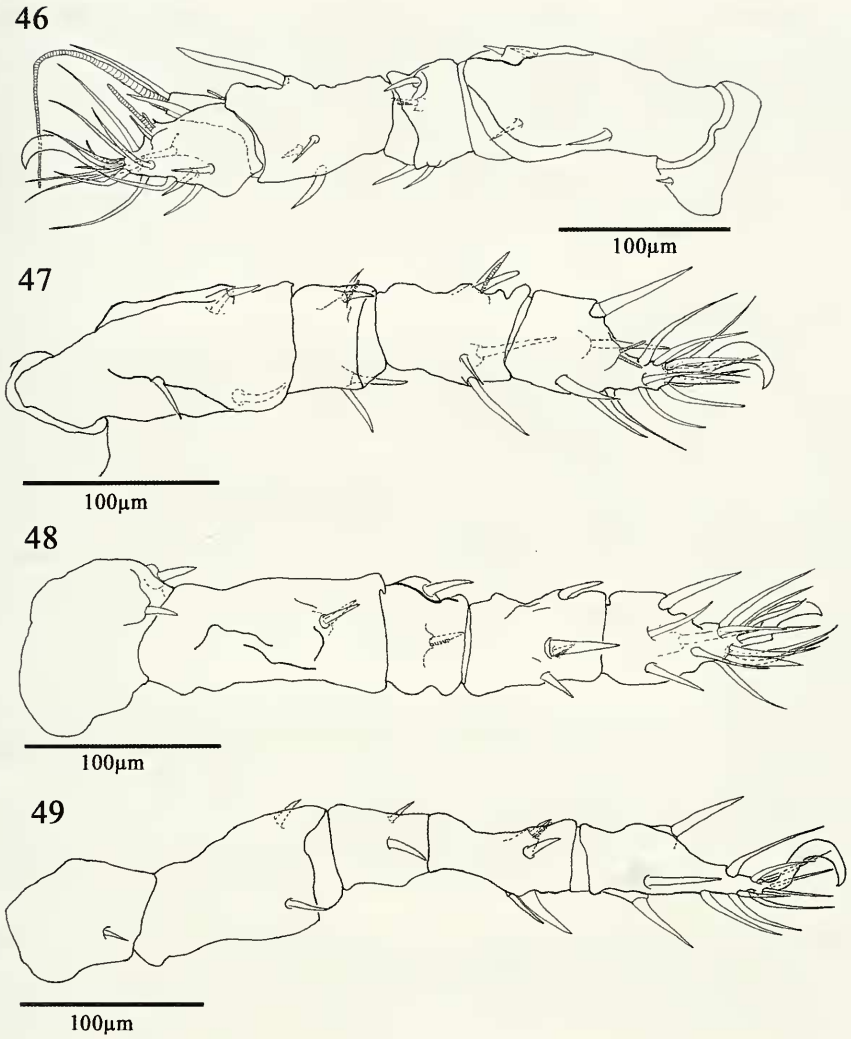
FIGS 42-45

S. minutus. Deutonymph. (42) Left leg I, antiaxial aspect. (43) Right leg II, antiaxial aspect. (44) Left leg III, antiaxial aspect. (45) Right leg IV, antiaxial aspect.

Saccules and brachytracheae can be found in different leg segments of several taxa of oribatid mites, but the occurrence of true tracheae in legs is very rare. They are known only from the ameronothroid genus *Aquanothrus* Engelbrecht, 1975 (Norton *et al.*, 1997) and from the here investigated licneremaeoid genus *Scutovertex*. This character might be useful for the diagnosis of the genus *Scutovertex*, as assumed by Grandjean (1940), but further comparative investigations are necessary to verify that.

JUVENILE INSTARS

Data on the external morphology of the juvenile stages of Scutoverticidae are available only in few cases. Michael (1884) gave a general description of a nymph of *Scutovertex sculptus* without information on the stage. Grandjean (1954) mentioned some characters of nymphs of an undetermined species of *Scutovertex*. Our



FIGS 46-49

S. minutus. Tritonymph. (46) Left leg I, antiaxial aspect. (47) Right leg II, antiaxial aspect. (48) Left leg III, antiaxial aspect. (49) Left leg IV, antiaxial aspect.

investigations on juveniles of *S. minutus* generated morphological features comparable with those described by Grandjean; therefore we assume that the latter author had used juvenile individuals of *S. minutus* in his study. Haarløv (1957) published an illustration of a tritonymph of *S. minutus* showing the dorsal side, the anal and genital region. The depicted rostral setae seem to be slimmer than those the specimens we examined.

Furthermore the tritonymphs of *Arthrovertex (=Argentinovertex) coineaui* (see Fernandez & Cleva, 2002) and of *Provertex delamarei* Travé, 1962 are known.

Due to the lack of knowledge on the morphology of juvenile Scutoverticidae it is difficult to compare *S. minutus* with congenerics and other species and to decide which of their characters are typical for the family or a certain genus and which are species specific. This matter becomes complicated if one follows the opinion of Woas (2002), who stated that on the basis of characters in adults the genera *Provertex* and *Lamellovertex* belong to the family Cymbaeremaeidae. In our opinion the available data on juveniles (and adults) are too poor to make a clear decision on this systematic question at the moment.

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